

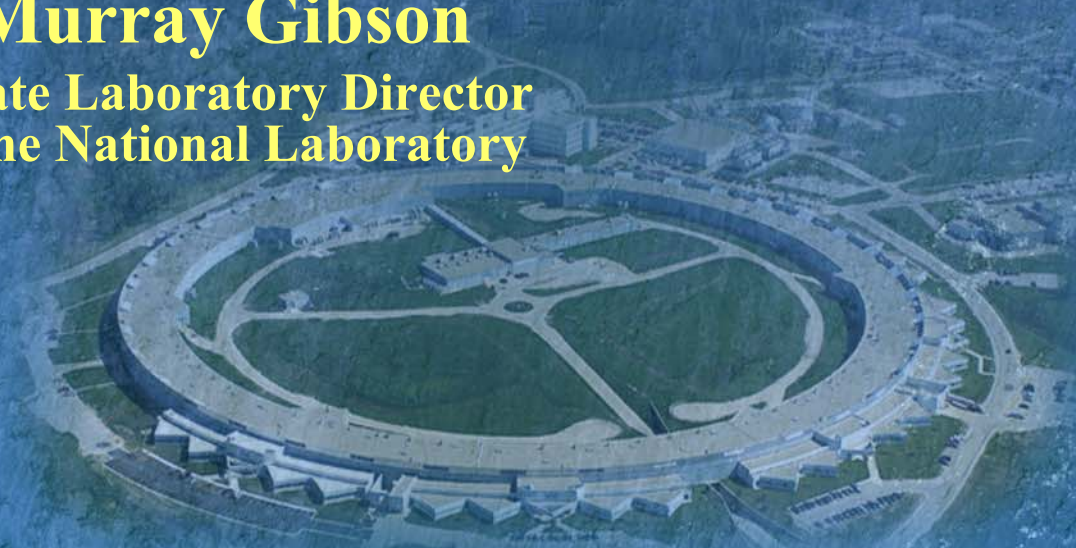


APS Update

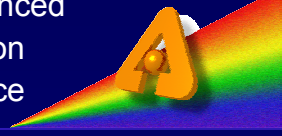
for the 2003 APS User Meeting
4/30/03

J. Murray Gibson

Associate Laboratory Director
Argonne National Laboratory



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Photon
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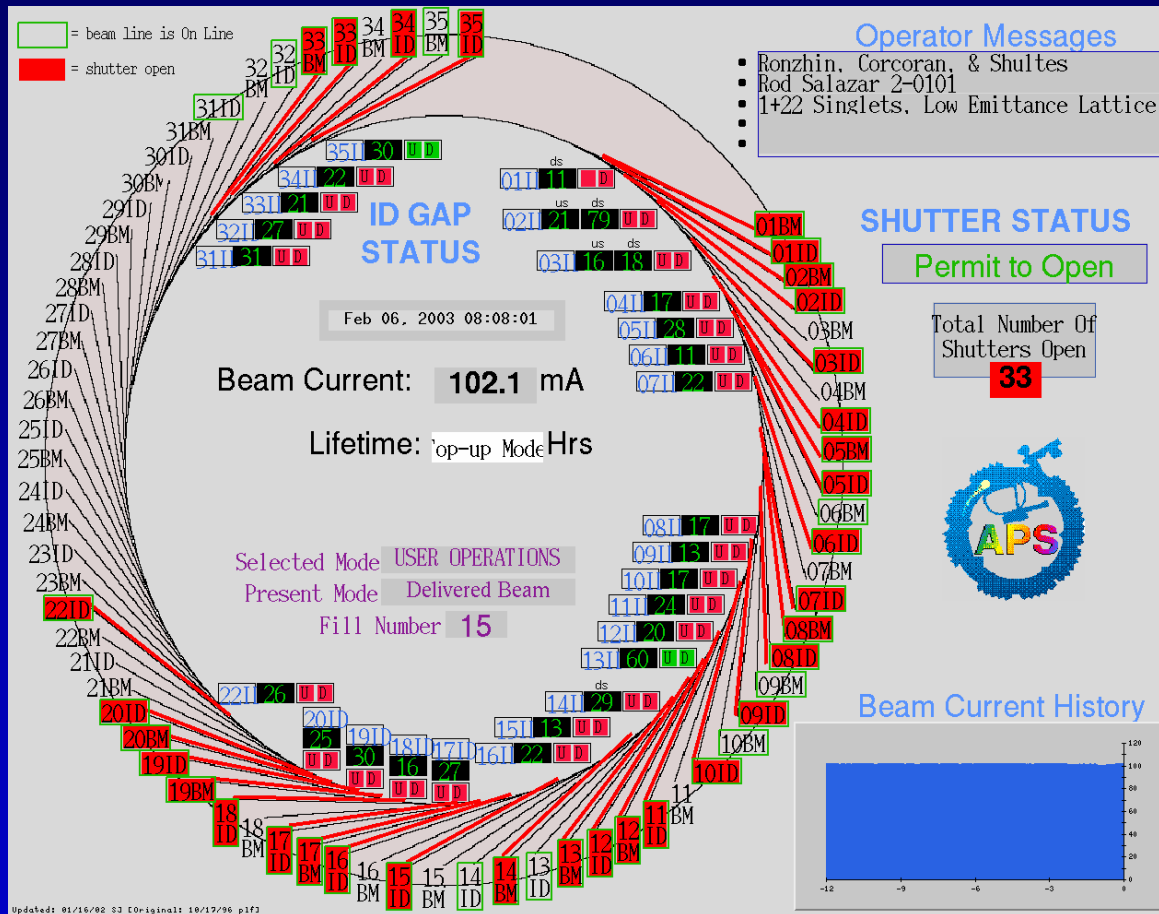
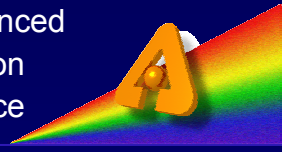


APS changes guided by mission:

- The mission of the Advanced Photon Source is to deliver world-class science and technology by operating an outstanding synchrotron radiation research facility accessible to a broad spectrum of researchers.
- Goals:
 - Operate a highly reliable 3rd-generation synchrotron x-ray radiation source
 - Foster a productive environment for conducting research
 - Enhance the capabilities available to users of the APS facility
 - Assure the safety of the facility users and staff and the environment
 - Maintain an organization that provides a rewarding environment that fosters professional growth
 - Optimize the scientific and technological contribution to the Department of Energy and society from research carried out at the APS

APS Today

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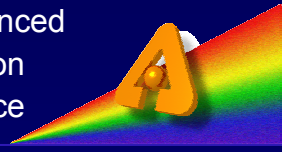


38 functioning
beamports
(25ID, 13BM)
68 total available

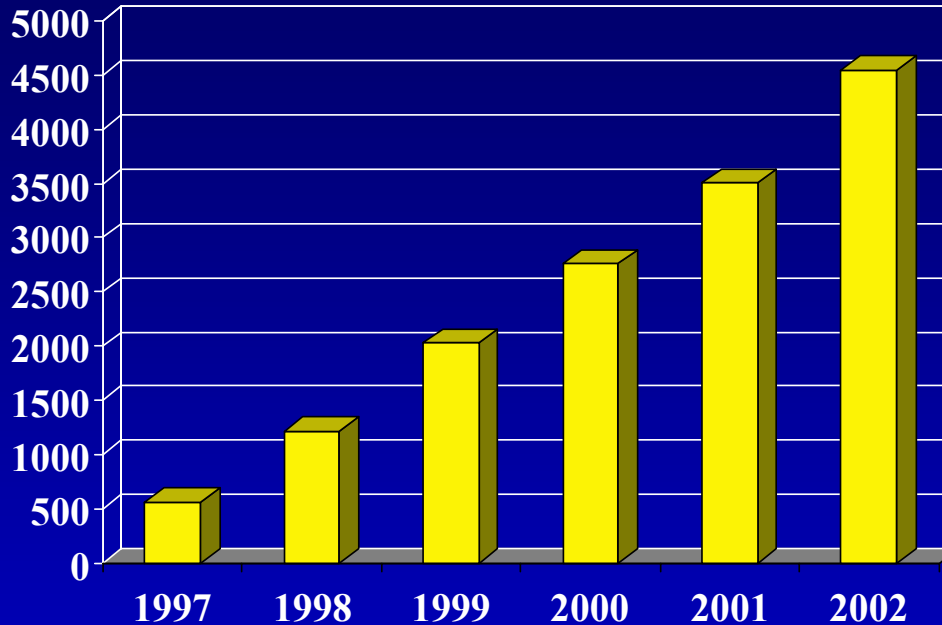
...only 4 ID
beamports
are not yet
committed

APS Users Today

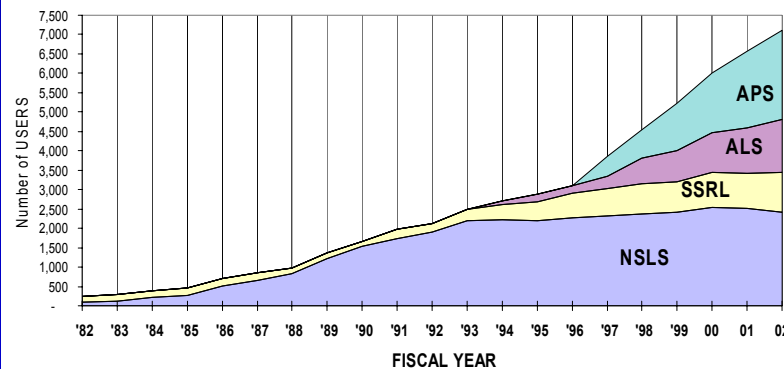
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Badged
Users

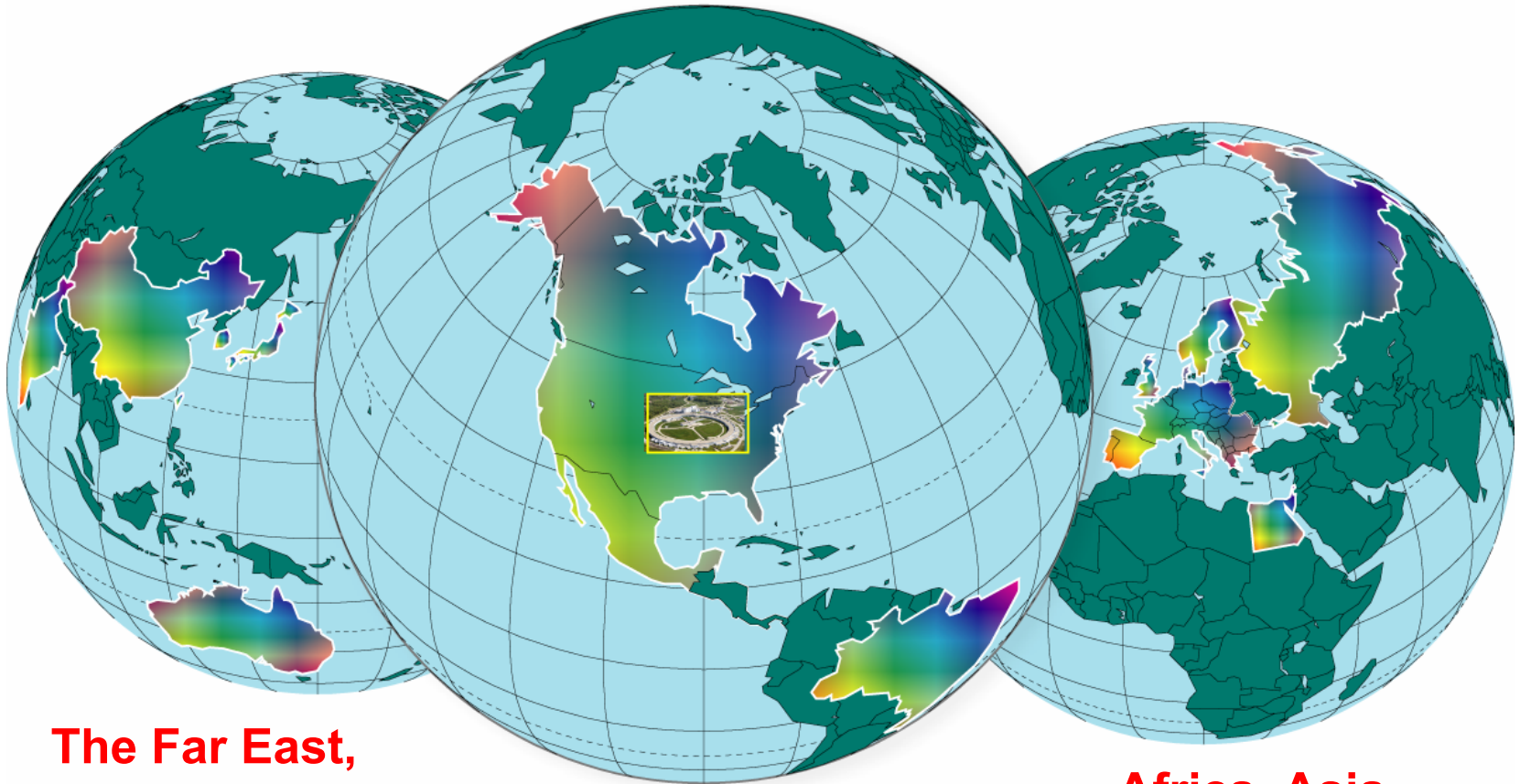
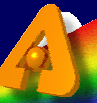


APS user
community
should reach
~10,000 in a
decade



APS Users around the world

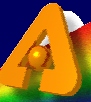
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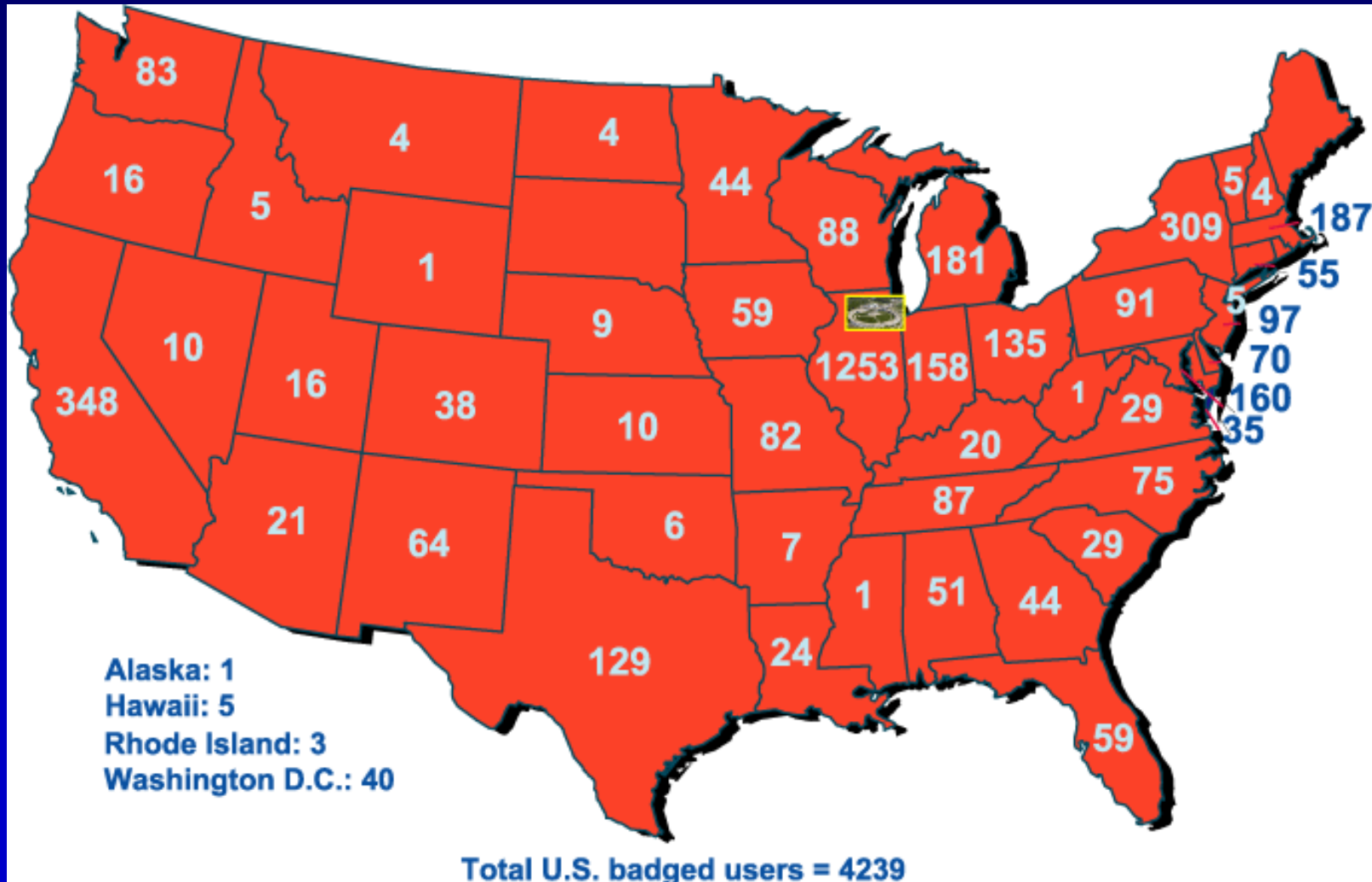
**The Far East,
South-East Asia,
the Subcontinent, &
the South Pacific:**
186

The Americas:
4227

**Africa, Asia,
Europe, &
the Middle East:**
391

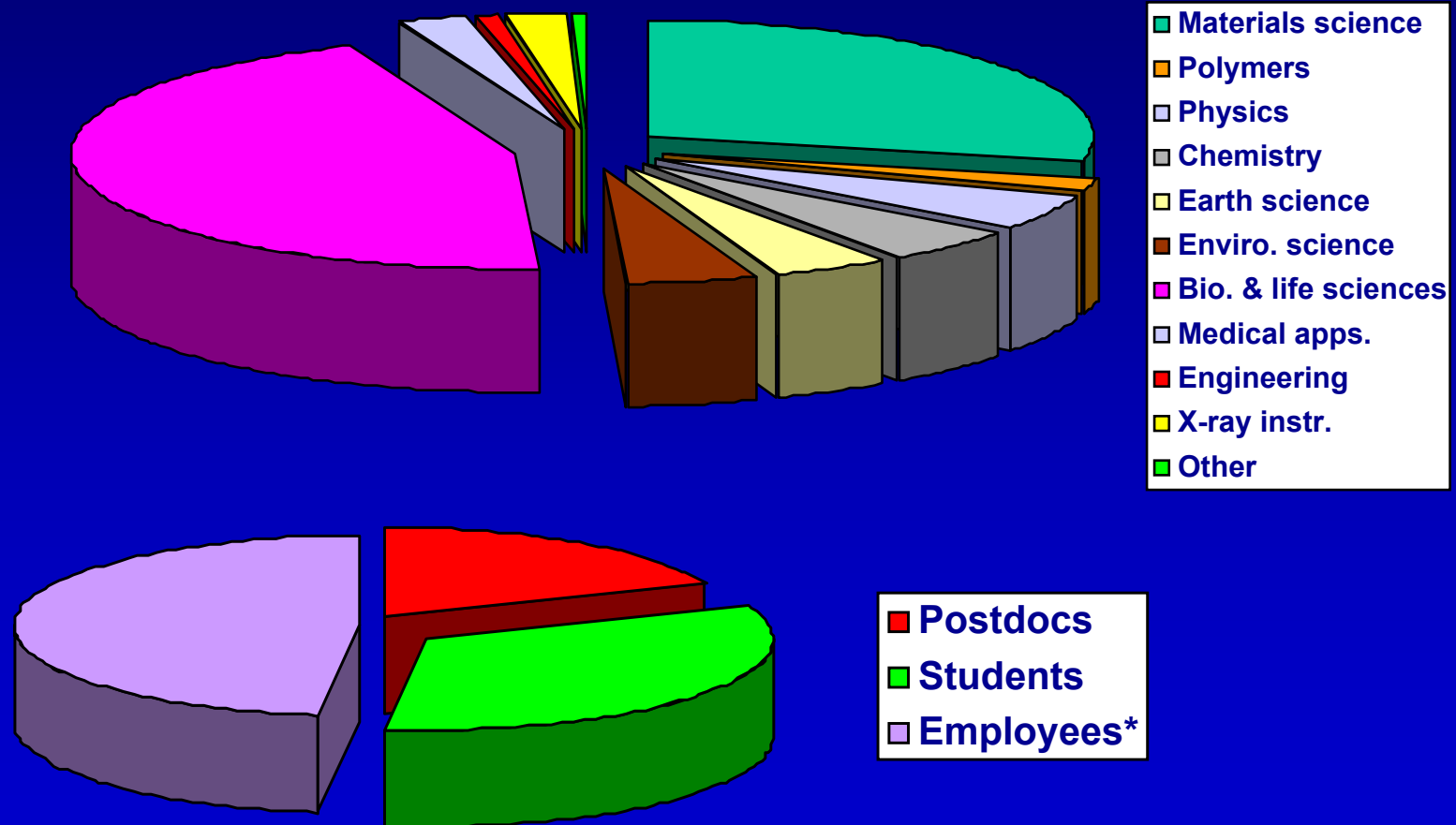
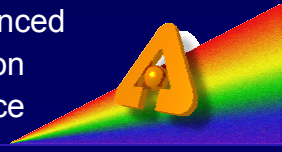


APS Users around the US



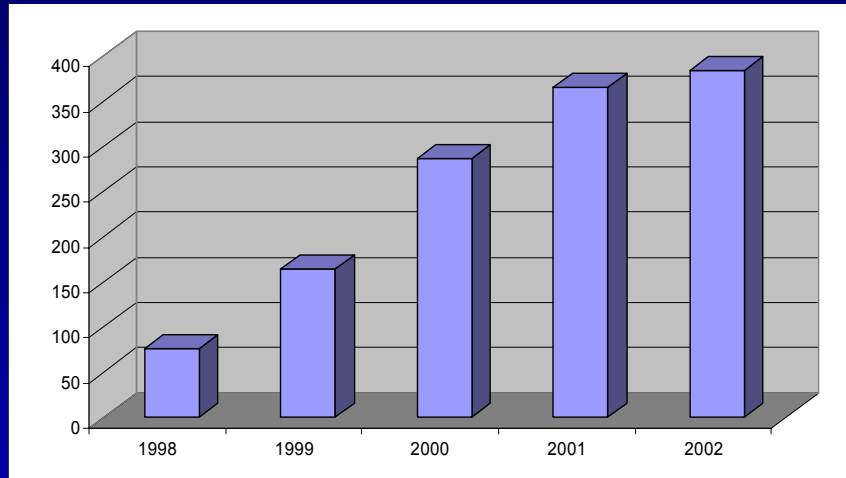
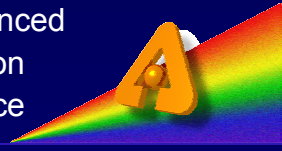
APS User Demographics (2002)

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APS scientific productivity grows..

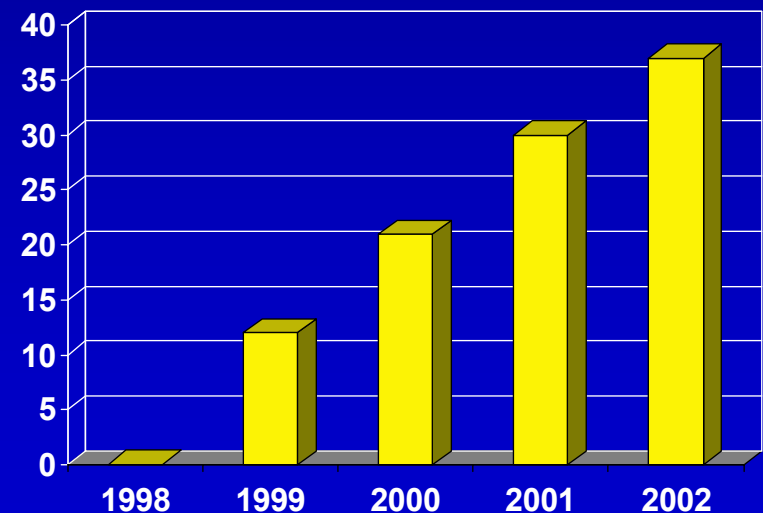
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Journal papers by calendar year

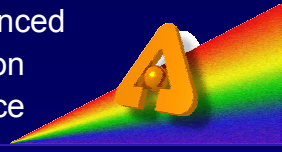
Overall APS refereed publications
per year exceeds 500

Protein databank deposits
as a fraction of
US synchrotron total



Our first *centralized* general-user program

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Proposal Review Panels							
Instrumentation	Imaging/ Microbeam	Macromolecular Crystallography	Scattering Applied Materials	Scattering Condensed Matter	Scattering Chem/Biol/Environ	Small Angle Scattering (SAXS)	Spectroscopy (EXAFS)
Eric Dufresne, Chair	Chris Jacobsen, Chair	Karl Volz, Chair	Paul Fuoss, Chair	Joel Brock, Chair	Neil Sturchio, Chair	Larry Lurio, Chair	Joe Woicik, Chair
Wilfried Schildkamp Sarvjit Shastri	Barry Lai John Miao Mark Rivers	Craig Ogata Amy Rosenzweig	I. Cev Noyan Carol Thompson Robert A. Winholtz	John Hill Ben Larson Young S. Lee Guoyin Shen Surendra Saxena	David Tiede Angus Wilkinson	Andrew Allen Jyotsana Lal David Londono Pappannan Thiyagarajan	Simon Bare Lisa M. Miller Sue Mini Matt Newville

Proposal Review
Panels
Beamtime Allocation
Committees

356 proposals submitted
for winter run 2003-02
~ 2000 shifts allocated
~ 46% success rate

Advanced Photon Source

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- Beam Time
- User Info
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- About Us
- Operations
- Search

Welcome to the
Advanced Photon Source

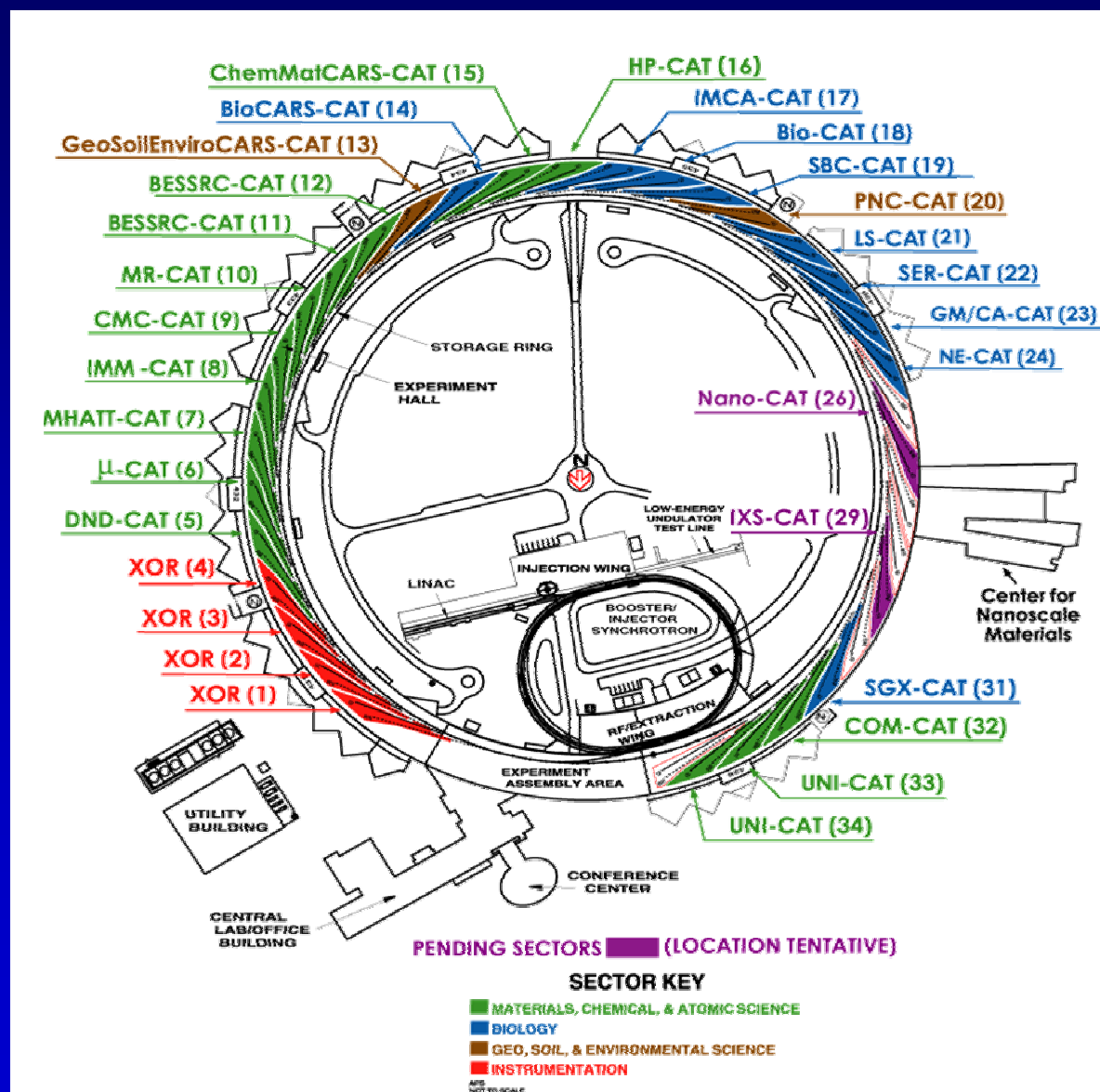
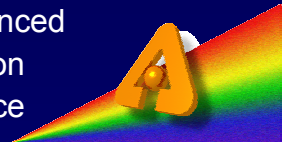
APS News
Tony Rauchs
In Memoriam
1946-2002
More Info

APS Techniques Directory

Technique	Beamline
Absorption/Spectroscopy	
Fluorescence spectroscopy	13-BM , 13-ID , 18-ID
Intensity fluctuation spectroscopy	12-ID , 7-ID
Photoemission spectroscopy (XPS)	12-ID , 4-ID-C
X-ray absorption fine structure (XAFS)	10-ID , 11-ID-D , 12-BM , 13-ID , 18-ID , 20-ID , 5-BM-D , 9-ID
X-ray magnetic circular dichroism (XMCD)	11-ID-D , 4-ID-C , 4-ID-D
Imaging	
EXAFS Microscopy	10-ID , 20-ID
Micro fluorescence	2-ID-B , 2-ID-D , 20-ID
Microprobe	13-BM , 13-ID , 2-ID-D , 20-ID , 7-ID
Phase contrast imaging	1-ID
Photoemission electron microscopy (PEEM)	4-ID-C
Radiography	1-BM
Tomography	13-BM , 2-BM , 5-BM-C
PROTEIN CRYSTALLOGRAPHY	
Macromolecular crystallography	14-BM-C , 14-BM-D , 14-ID , 17-ID , 19-BM , 19-ID , 5-ID
Multiwavelength anomalous dispersion (MAD)	14-BM-C , 14-BM-D , 14-ID , 17-ID , 19-BM , 19-ID

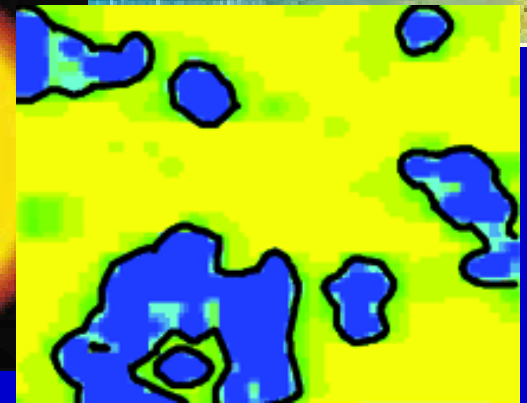
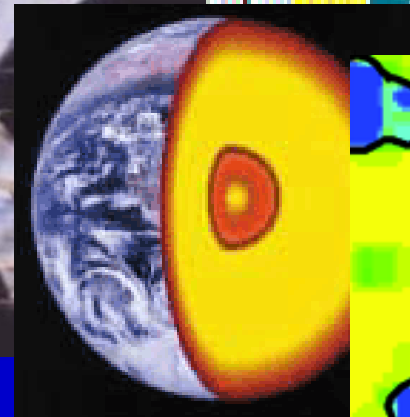
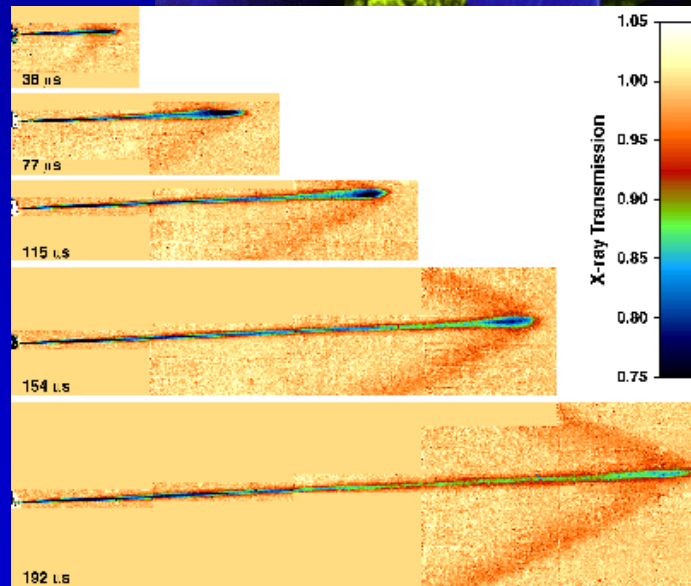
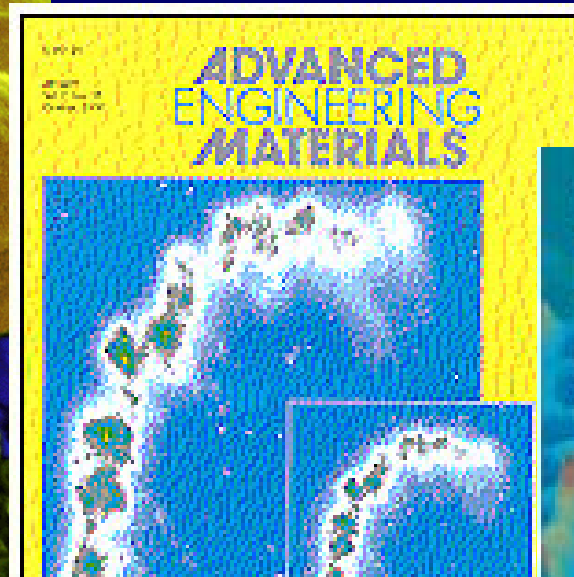
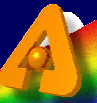
Partnerships for the future...

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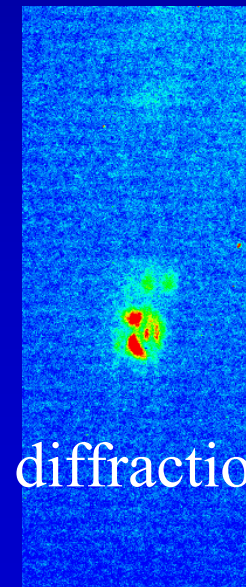
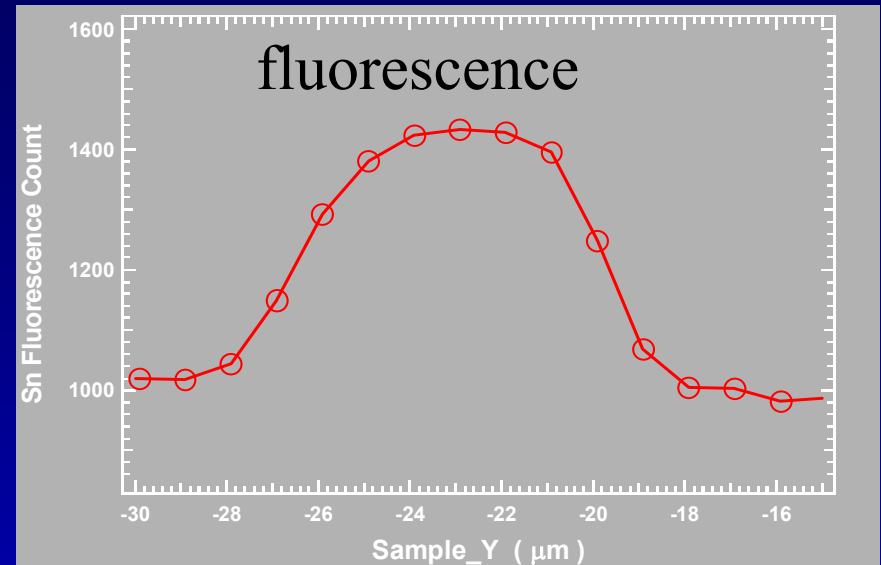
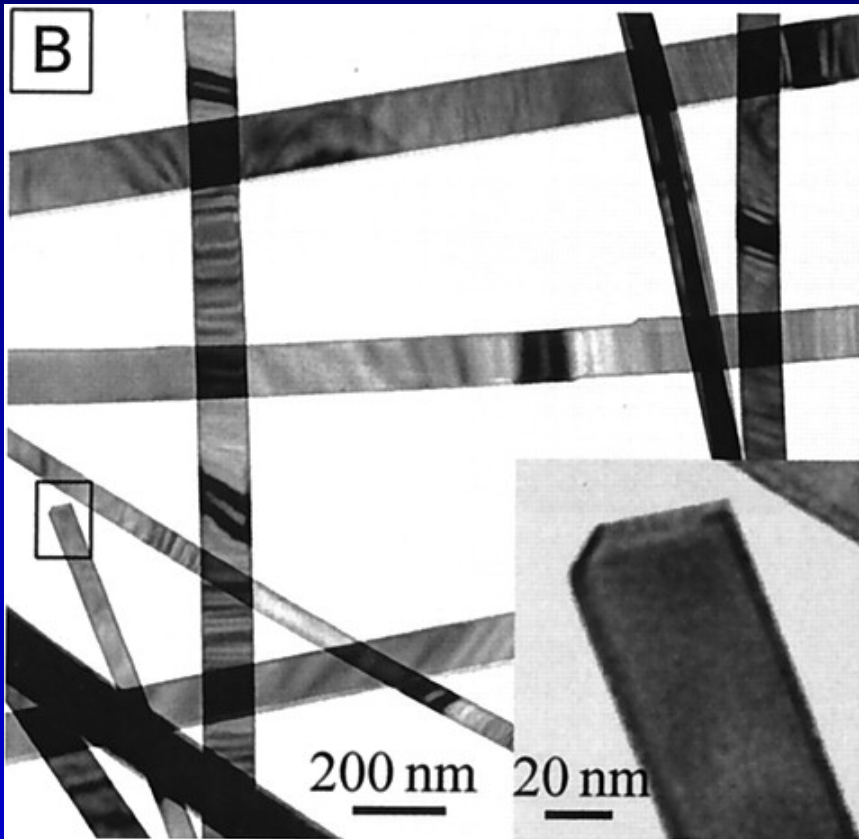
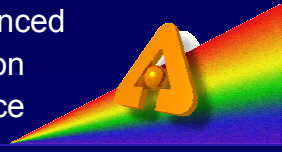
Impact on physical sciences....

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Imaging nanostructures..

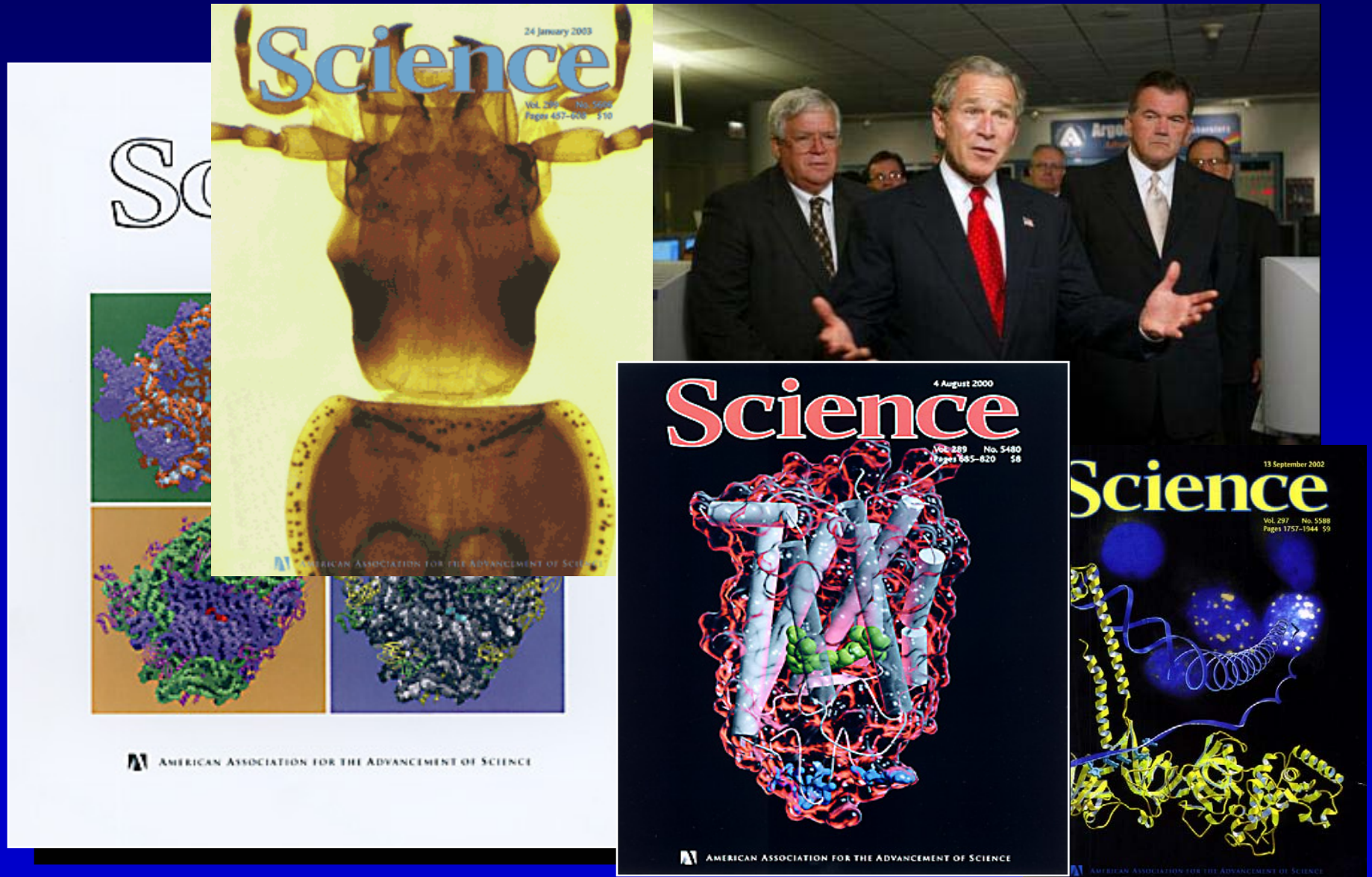
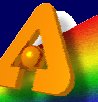
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Sn_2O_3 nanobelts – Z. Cai

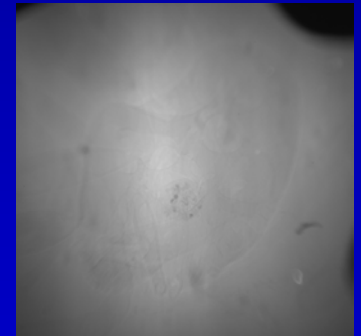
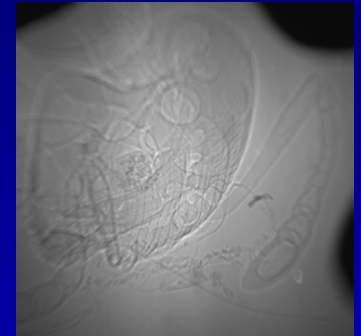
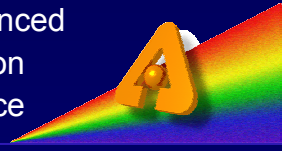
Impact on biological sciences...

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Ants Pant!

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Phase-enhanced
imaging

Westneat, Lee et. al..

Argonne video turns ant into a science celebrity

By Jeremy Manier
Tribune staff reporter

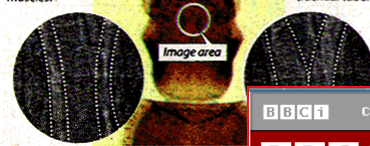
tered into an insect's body from
the outside with only some ac-

Bugs caught 'breathing' on camera

Researchers at Argonne National Laboratory have captured beetles, crickets and ants on X-rays that show insects inhaling and exhaling. Scientists had thought bugs took in oxygen through passive diffusion.

Wood beetle under X-ray
Circular X-ray images taken 0.5 seconds apart.

Compression:
Likely caused
by contraction
of jaw or limb
muscles.



Expanding:
The muscles relax,
expanding the
tracheal tube.

Sources: Argonne National Laboratory, www.sciencemag.com

Chicago Sun-Times

FRIDAY, JANUARY 24, 2003

Very close look finds how bugs breathe

Scientists open tiny window into what makes insects tick

By Nancy Morvett
Staff Reporter

If you had a really, really powerful X-ray beam, like a billion times stronger than normal, what would you look at?

Physicist Wah-Keat Lee focused on the head of a dead ant. Lee, of Argonne National Laboratory, was so struck with what the superpower beam from the synchrotron, particle accelerator revealed that he went looking for a biologist to help interpret it.

Now, he and the Field Museum's associate curator of biology report in today's Science magazine that they have captured video of tiny, previously unknown mechanisms using X-ray beams.

It gives us a high-resolution, really tiny window into how insects work," said Mark Westneat, whose chief interest is in fish and human chorion.

He knew insects took in oxygen in several ways opening up little ports on their sides, pumping the abdomen—as you can see if you watch a bee sitting on a flower, heaving its wings or beating wings near modified sacs that puff air in and out.

But when, with Argonne's real-time video technology, Westneat could watch tiny structures for the first time in motion, "you see something different," he said.

That difference was compression of the broadened tubes. They pump volume more quickly. From the first look, the re-



Argonne's superpowerful X-ray beam has taken a close-up look at a wood beetle, seen under a microscope.

"We say that this is a long-time mechanism. We don't want to say that insects have lungs, because they don't," he said.

The tracheal tubes were seen in beetles, crickets, ants, butterflies, cockroaches, dragonflies and other insects.

The research "wakes us aware of something we were completely ignorant of before," said Mike Lafrankie, invertebrate biologist at the University of California at Berkeley, who was not involved in the research. "Despite literally thousands of people working on insects, nobody had any inkling"

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A Bug's Breath X-Rays Settle Mystery of Insects' 'Lungs'

By Erik Weiss

Washington Post Staff Writer
Friday, January 24, 2003; Page A01

Exposing insects to X-ray beams a billion times more powerful than the ones that doctors use, researchers have at last settled one of the longest-running -- if lesser-known -- controversies in science: Bugs, it turns out, do breathe.

Small, and by some measures it is structures that scientists were able to only on high-definition X-ray videos in the comma in this sentence.

ever, the evidence that insects actively hing less than historic, closing the dates back to Aristotle, who at insects are alive but scoffed at the te.

tracheal tubes in the head and thorax, parts of the body, really squeezing and V. Westneat of Chicago's Field, story who led the study -- the first to motion beam to create a movie of a ey're not lungs, but they're lung-like."

It said, could lead to new insecticides, that kill insects by asphyxiating anology might eventually be adapted people.

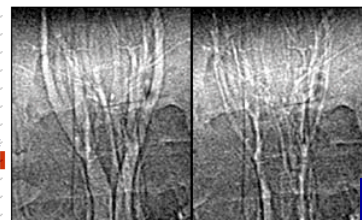
atomologists hewed largely to Aristotle's view, believing that air simply drifted into and out of tiny holes in insects' bodies. More recently it became clear that insects actively pump air through these holes by moving their bodies in particular ways.

But only now, with the creation of the first laser-like videos of living, breathing insects, is it clear that insects -- like people -- use muscles specifically to inhale and exhale, even when the

BBC NEWS

News Front Page World UK Ireland Europe Africa Asia Pacific Americas

Insects squeeze to breathe



Expand and compress: An insect works the air Scientists have used X-ray video to study how insect breathe.

Unlike humans, which have lungs and blood to push oxygen to vital organs, an insect sends air directly around its body via a set of internal pipes running fi holes in its external skeleton.

Although these tubes have long been known about, the X-ray pictures have revealed impressive new details of their workings.

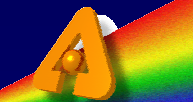
The researchers were able to see how the pipes - called tracheae - can be squeezed

Wah-Keat

Wah-Keat

Wah-Keat

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SPiEGEL ONLINE WISSENSCHAFT

Übersicht Weltraum Erde Mensch & Technik

RÖNTGENVIDEO

SCIENTIFIC AMERICAN
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NEWS

January 24, 2003

Ultrapowerful X-Rays Reveal How Beetles Really Breathe

printer-friendly version subscribe

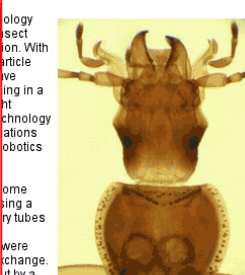


Image: MARK WESTNEAT courtesy of the Field Museum

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Education
Special Reports

X-ray shows how bugs really breathe

Friday, January 24, 2003 Posted: 12:09 PM EST (1709 GMT)

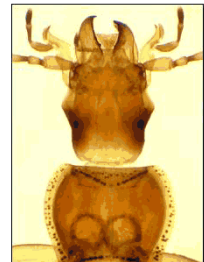
WASHINGTON (AP) -- Bugs don't have lungs, so how do they breathe? Maybe more efficiently than people, according to the first close-up view of insects forcing air in and out of tiny oxygen pipes.

It took one of the world's strongest X-ray beams -- a view hundreds of times more detailed than today's most sophisticated



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Technology & Science SCIENCE NEWS



A wood beetle, Platyrus decemlineatus, with tracheal tubes visible at the junction of the head and thorax.

X-rays show how bugs breathe

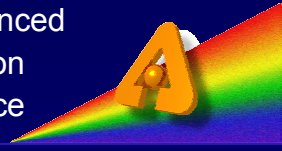
First close-up view of insects forcing air through tiny pipes

ASSOCIATED PRESS

WASHINGTON, Jan. 23 — Bugs don't have lungs, so how do they breathe? Maybe more efficiently than people, according to the first close-up view of insects forcing air in and out of tiny oxygen pipes. It took one of the world's strongest X-ray beams

Annual Report of the APS

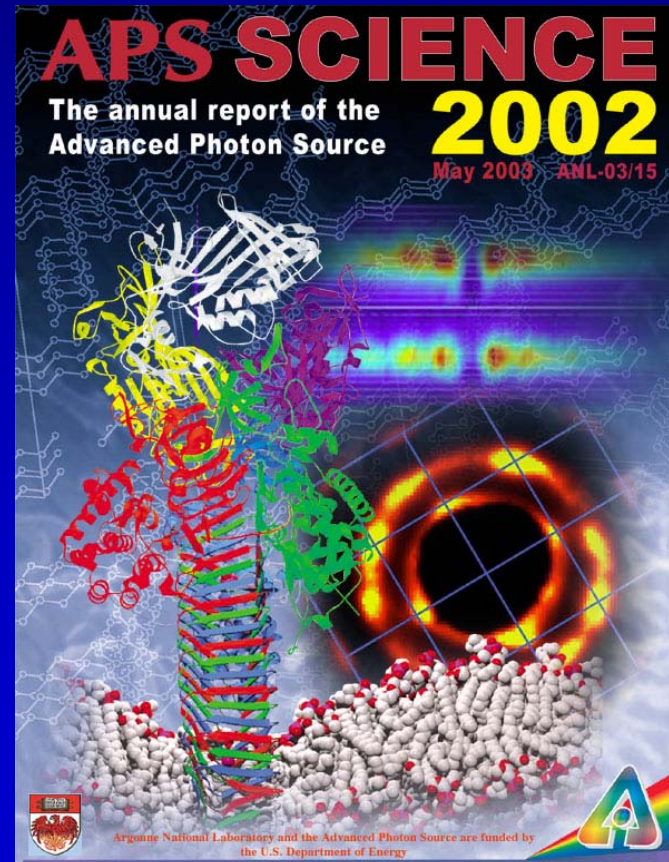
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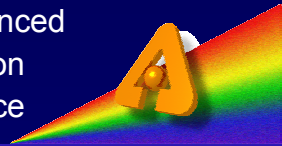
Available at

http://www.aps.anl.gov/wrknet/aps_sci02.html

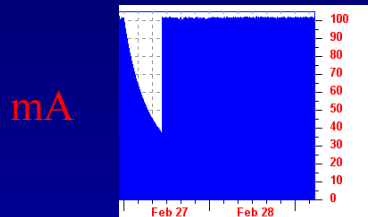
To be mailed
to all users by
end of May 2003



Continuing performance improvements



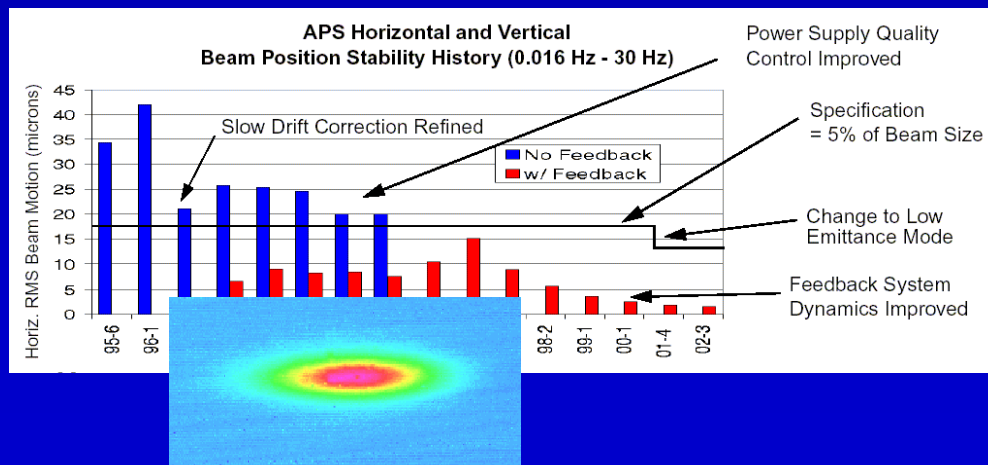
- Top-up operation



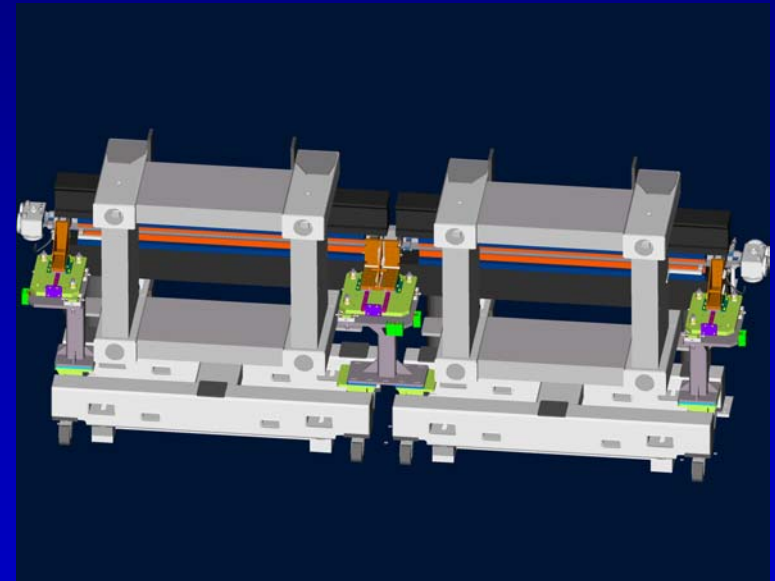
–Low emittance

–Stable optics

- Improved beam stability



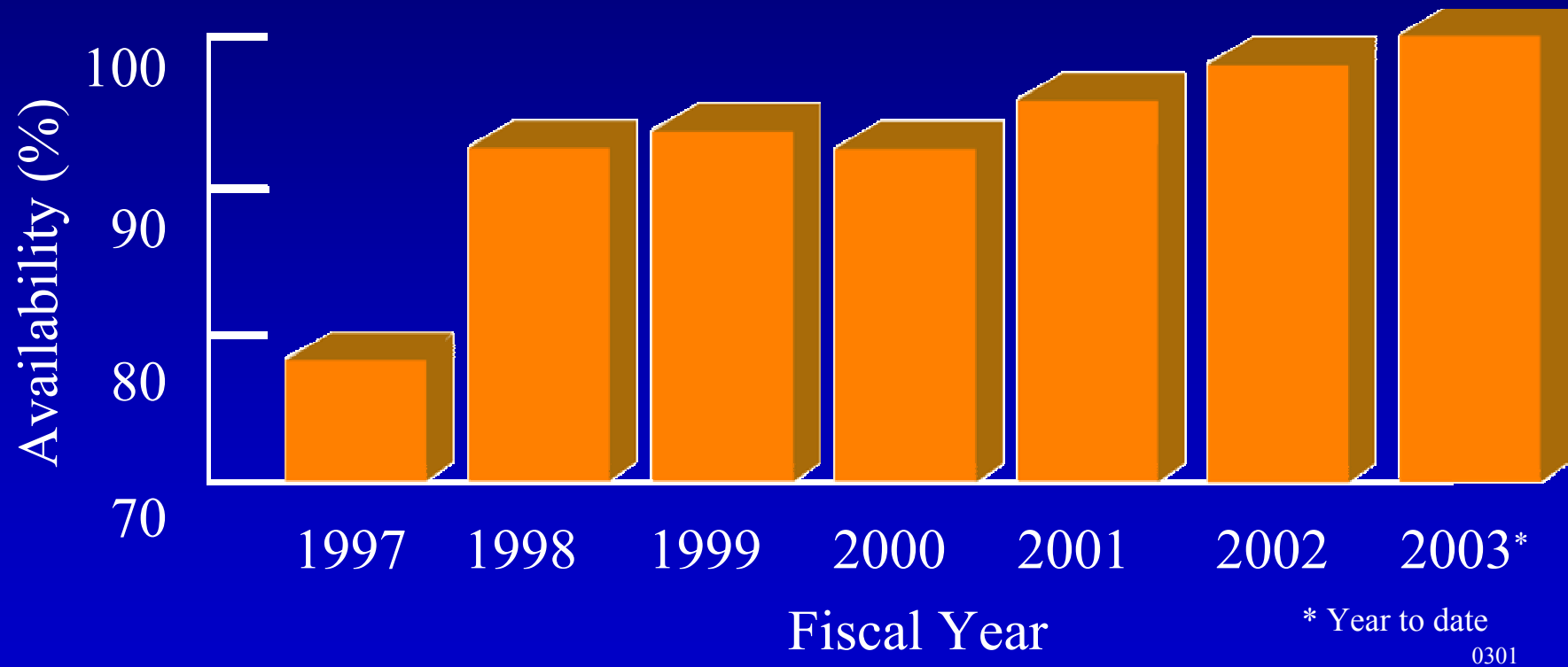
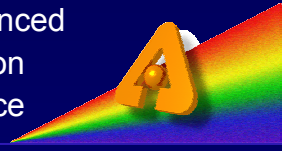
Canted Undulators



- demanded by bio users

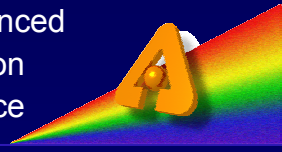
while increasing reliability...

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APS Science Tomorrow - State-of-the-Art 3rd Generation Science in 20 Years?

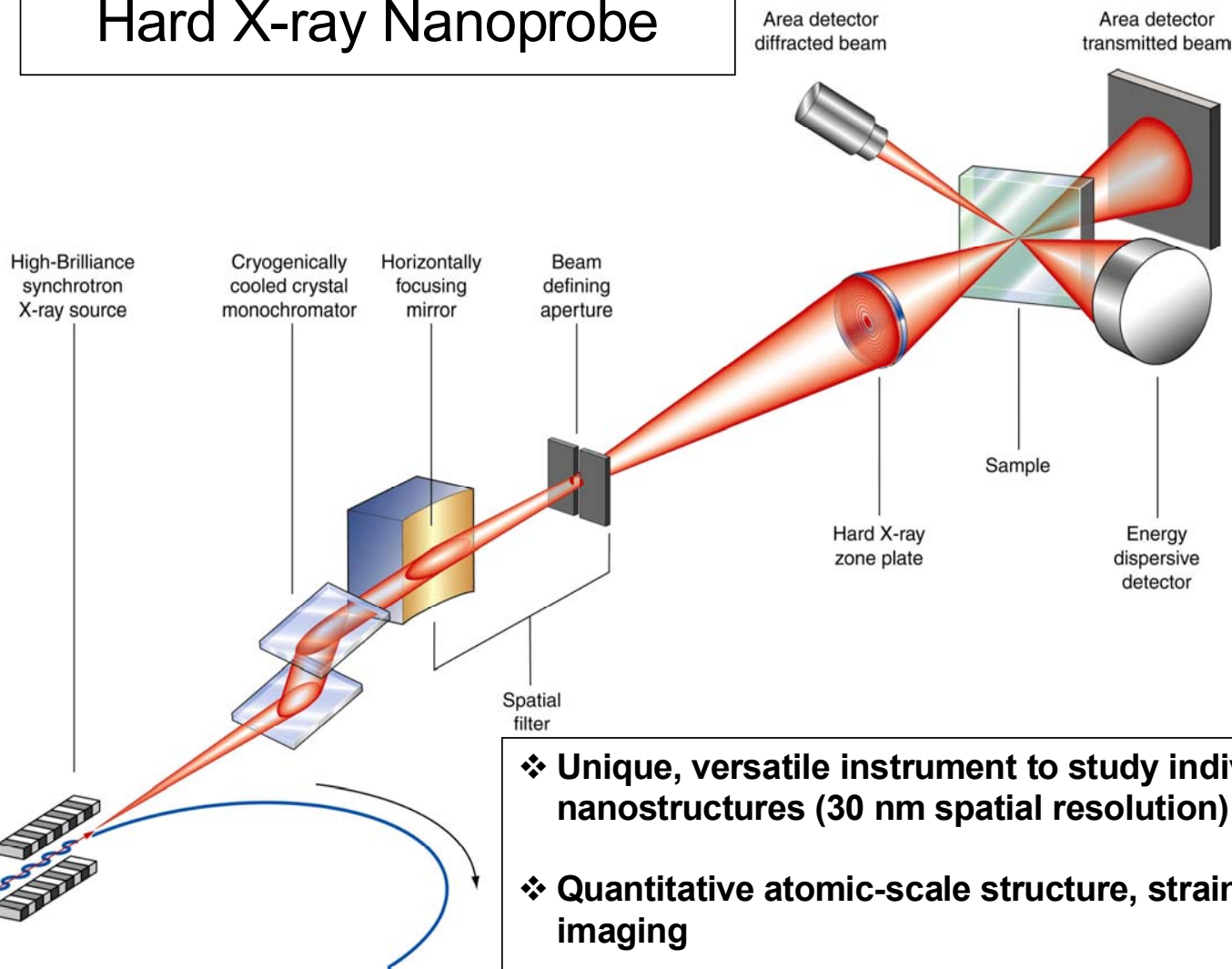
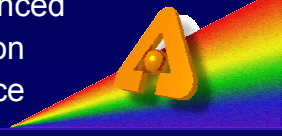
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- *Individual* nanoscale objects can be observed in *real-time*
- Electronic, dynamic and magnetic properties of a *single nanostructure* can be measured
- *A few atoms* can be chemically identified
- A full dataset for protein structure analysis can be collected in *less than a second*
- X-ray imaging of objects with *nm resolution* is routine

Hard X-ray Nanoprobe

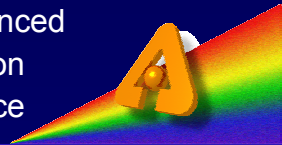
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- ❖ Unique, versatile instrument to study individual nanostructures (30 nm spatial resolution)
- ❖ Quantitative atomic-scale structure, strain, orientation imaging
- ❖ Sensitive trace element and chemical state analysis
- ❖ Ability to penetrate overlayers, environments, fields

Center for Nanoscale Materials

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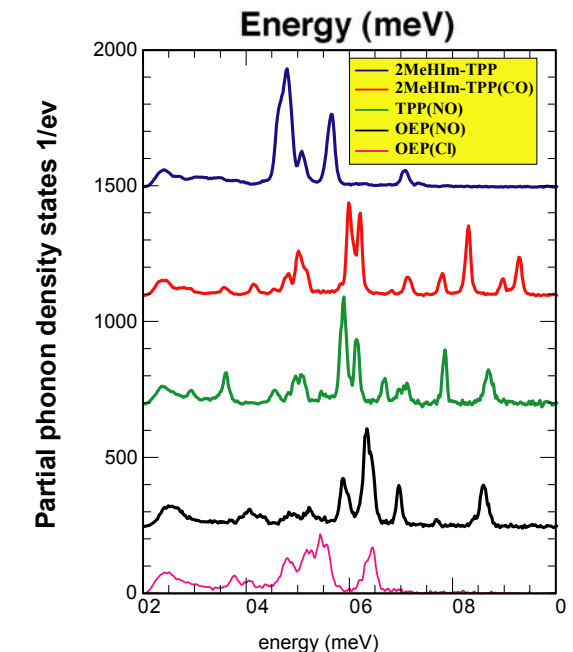
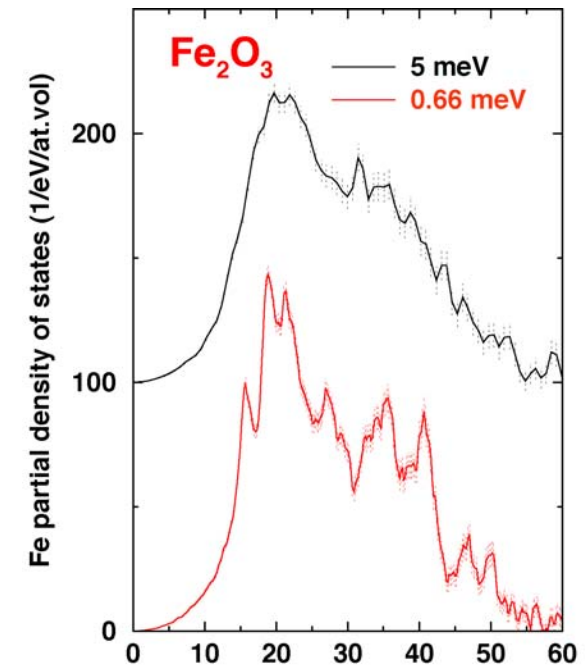
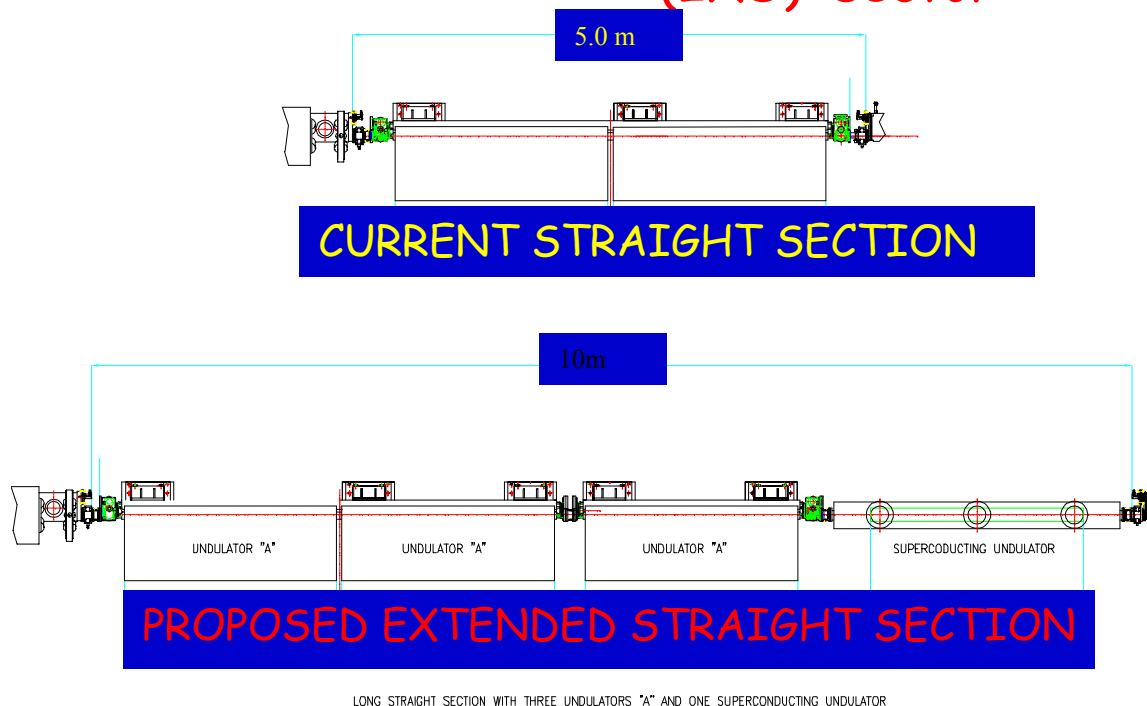


State Contribution FY'02 = \$2M, FY'03 = \$17M
Building construction begins Summer '03
DOE approves CD-0, anticipated funding \$30-40M

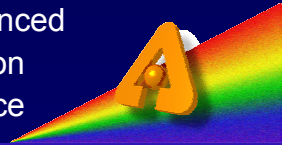


User facility for Nanosciences and Nanotechnology
<http://nano.anl.gov/>

Extended straight section for inelastic x-ray spectroscopy (IXS) sector



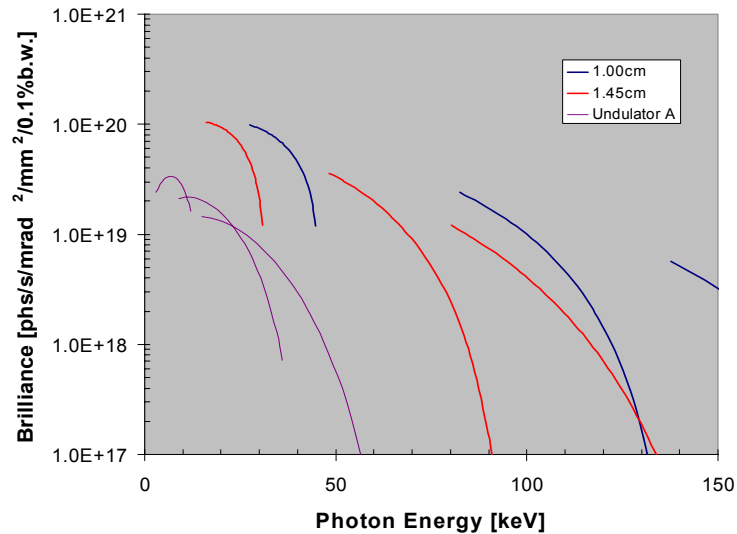
- The heme doming coordinate in myoglobin is directly involved in the oxygen-binding reaction
- Doming modes are expected in the range of 6-8 meV
- With a high enough resolution it becomes possible to study the influence of addition of ligands to the functional behavior of proteins



Preparing for tomorrow...

- Complete remaining beamlines (Phase I)
 - Optimized for best science and accessibility
- Optimize x-ray sources by sector (Phase II)
- Take advantage of detector, automation and optics improvements (Phase III)
- Upgrade accelerator & injector in 15 years (Phase IV)
 - Connect with next-generation capabilities
- *Proposed Phased Plan to Define State-Of-The-Art 3rd Generation; 20 years, 4 order of*

R&D On Insertion Devices

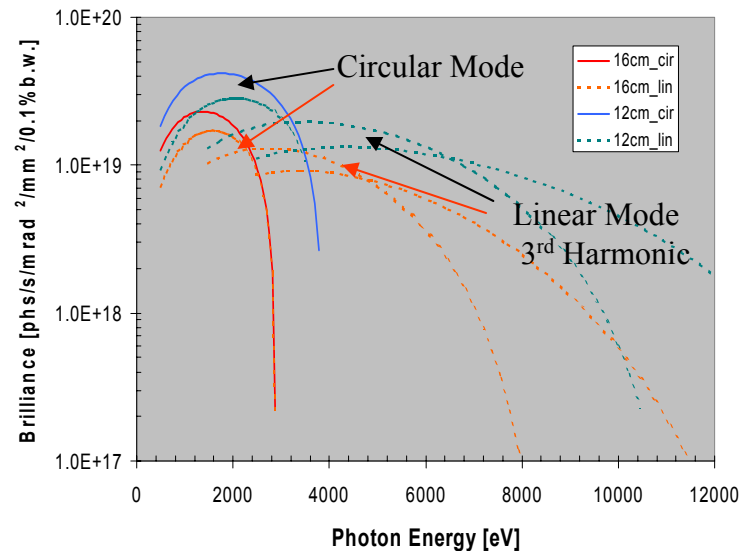


Superconducting Small Period Undulator

1.45 cm period
L=2.4 m, N=165
Gap=7 mm
Maximum K = 1.4

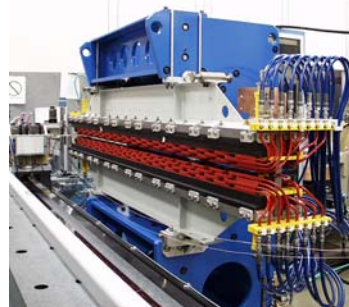
1.00 cm period
L=2.4 m, N=240
Gap = 3 mm
Maximum K = 1.17

Variable Polarization Undulator



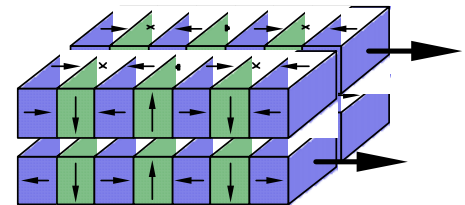
Electro-magnetic Device

$\lambda=16$ cm, L=10 m, N=62

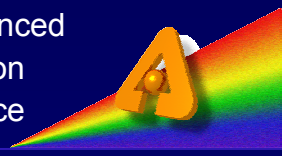


APPLE type PM Device

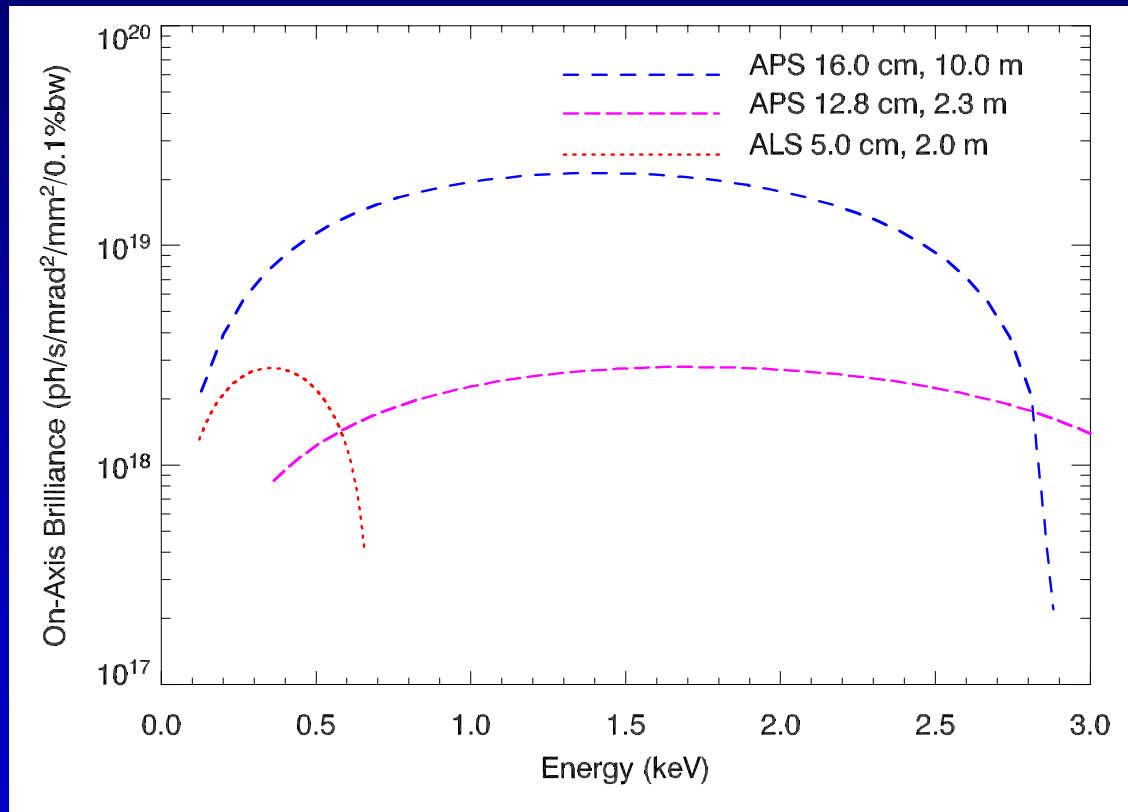
$\lambda=12$ cm, L=10 m, N=82



Assumed APS storage ring parameters: 3.5 nm-rad, 1% coupling, 100 mA



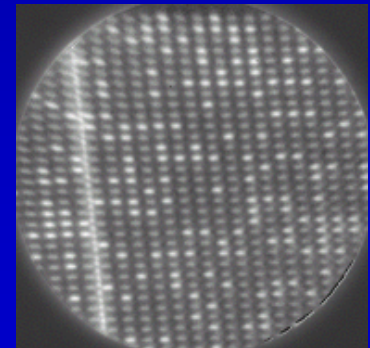
Brilliance Tuning Curves for Elliptically Polarized Devices



Advantages of high energy rings:

- Low emittance
- High beam stability
- Large energy tunability

⇒ **Superior performance**



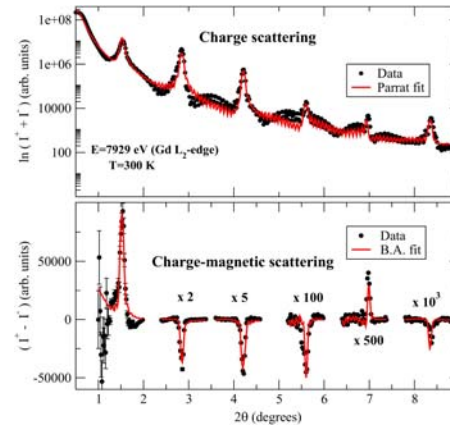
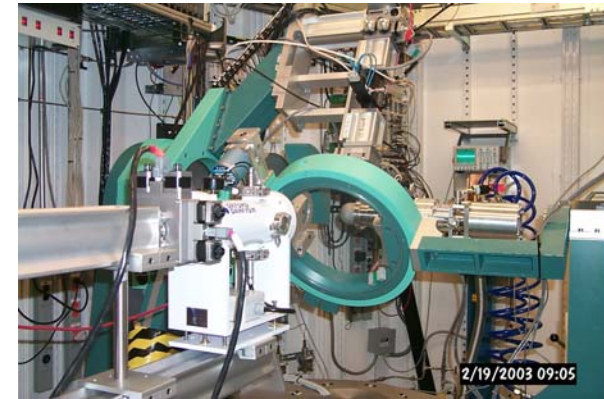
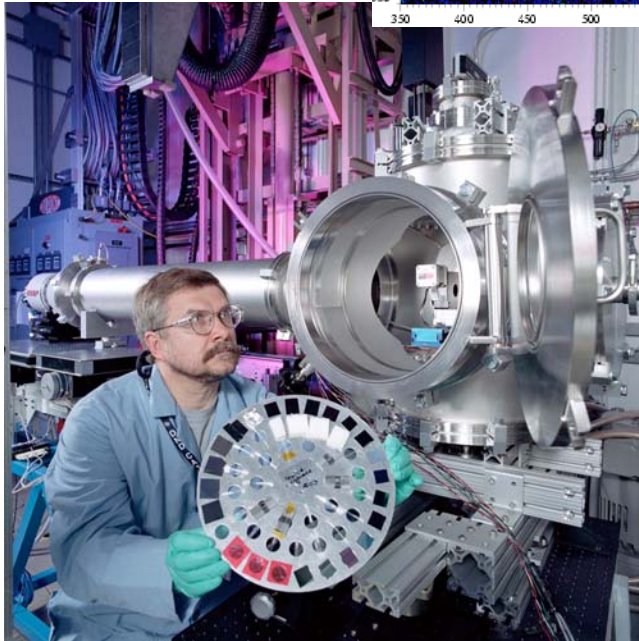
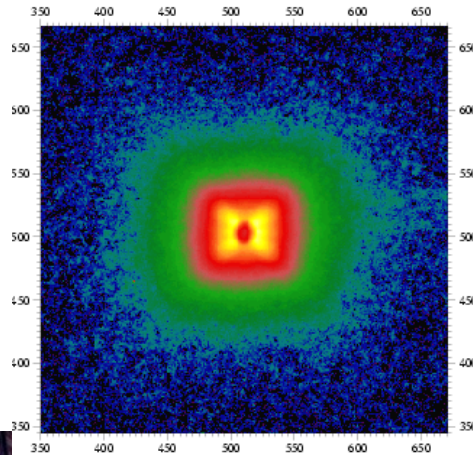
APS (7 GeV, 100 mA): 10 m long straight section, $\lambda = 16.0$ cm, $N = 62$

APS (7 GeV, 100 mA): 5 m long straight section, $\lambda = 12.8$ cm, $N = 18$ (current device)

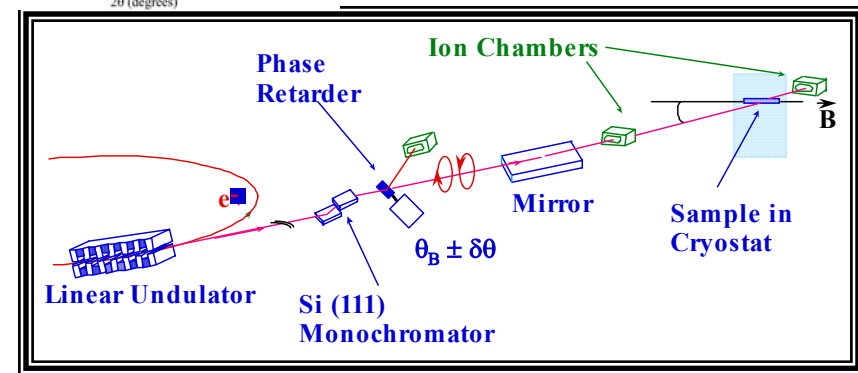
ALS (1.9 GeV, 400 mA): 2 m long straight section, $\lambda = 5.0$ cm, $N = 37$

Two kinds of beamlines:

*a “turnkey”
beamline to
efficiently
collect - SAXS*

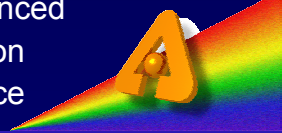


*a dedicated
beamline to
“do experiments” -
magnetic scattering*

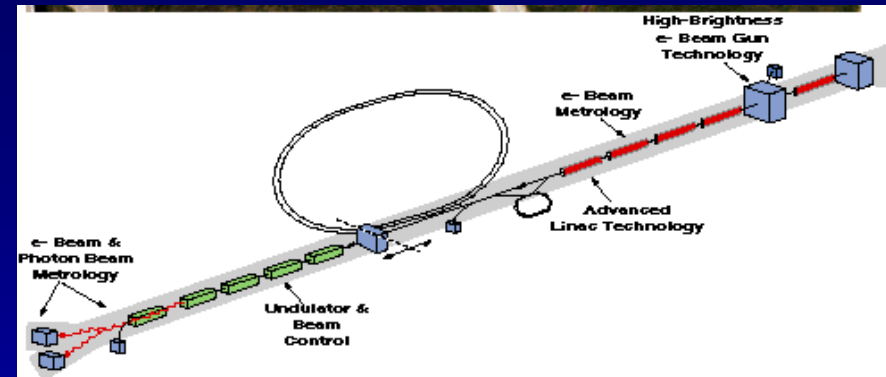


Free-Electron Lasers – *the excitement of fs science*

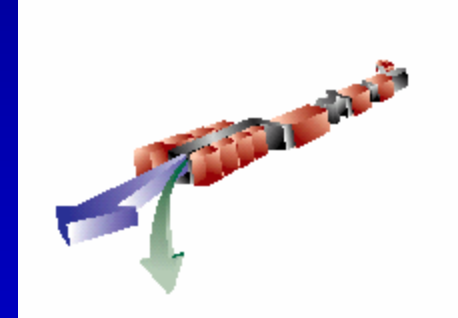
Advanced
Photon
Source



- LEUTL has SPIRIT
 - Experiments ongoing to use single photon ionization from LEUTL source for materials science
 - Proposal submission to BES for upgraded, independent facility (decision point FY '04)



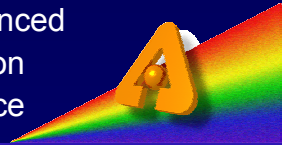
- LCLS  **LCLS** 
Linac Coherent Light Source



APS to provide undulators at ~\$50M responsibility
Steve Milton is the ANL LCLS Project Director

Science Advisory Committee (SAC)

Advanced
Photon
Source



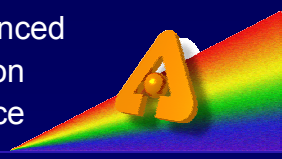
- Fourteen members plus ex-officio APSUO Chair and Partner User Council Chair
- Inherits and expands responsibilities of Program Evaluation Board
 - Advises on scientific directions for APS
 - Evaluates performance of sectors and CATs
 - Stand-alone Sector Review Panels
 - Evaluates new partner proposals
 - Advises on policy
- Annual cross-cutting review – “Science with Microbeams” to be held January, 2004
- Formulated new policy on partner users
- Invited Study Panel on “New Scientific Directions for APS” chaired by Gopal Shenoy and Sunil Sinha (roundtable discussion tomorrow)

Science Advisory Committee first meeting



Howard Birnbaum

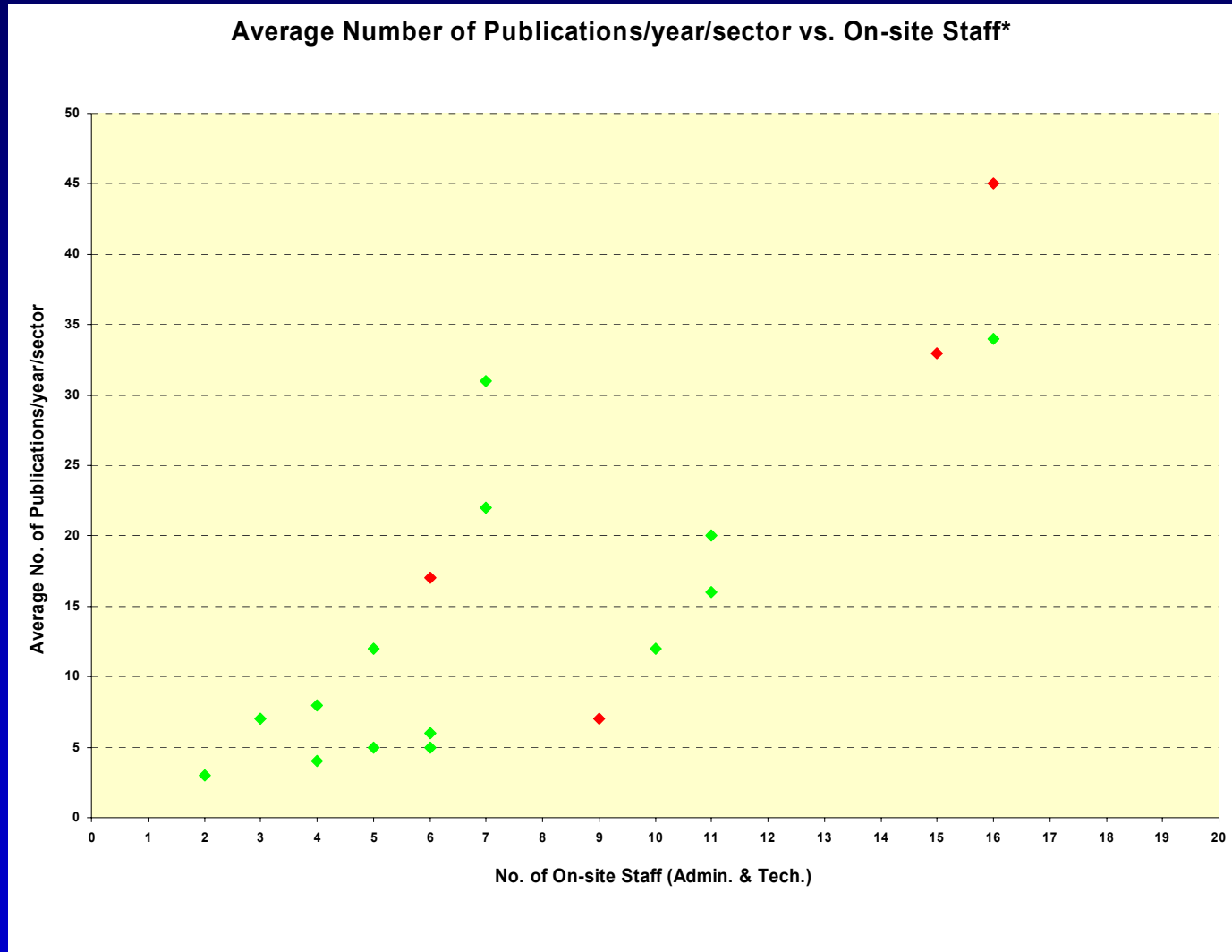
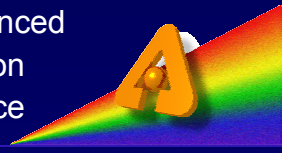




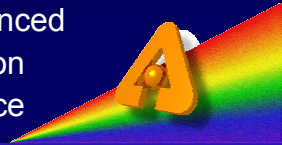
“APS as a teenager..”

- The facility is maturing and evolving
 - Appropriate change is healthy to deal with challenges
- CAT system has worked well in many ways
 - Leveraging of funds
 - Outside drivers and partners for facility
 - Strong connection with universities
 - Creative diversity
- But faces challenges
 - Tendency to avoid specialization and ignore duplication
 - Increased operational burden
 - Challenge for some to sustain adequate operational support
- Facility is being asked to take on responsibility for operating BES sectors
 - Offers attractions of stable operations, more high-end dedicated instruments and improved efficiency
 - More resources will be needed, included in our long-range plans
- Need new more flexible partnering models incorporating strong CATs
- APS is increasing user support in general
 - Significant realignment of resources towards user side in 2002

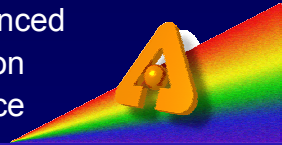
Compelling need for more sector operational support



unsurprising relationship between support level and productivity

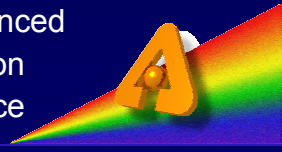


- “Partner Users” do great science and
 - *add* to the facility and general users in some way
 - e.g. build and/or operate a beamline or endstation
 - develop a new user community...
 - CATs are an important and continuing example
 - We offer more flexibility in future
 - e.g. limited scope partnerships
 - <15% beamtime for two years requested
 - Only available on sectors offering more than 25% GU time
 - » Or APS run sectors offering more than 50% GU time
 - **Call for proposals due by June 1st for Fall 2003-03 run**
 - PU proposals are evaluated and regularly reviewed by the SAC



XOR faces the future...

- X-Ray Operations and Research (XOR) in APS X-Ray Facilities Division
- Former SRI CAT embraces need
 - To continue innovation in instrumentation
 - To build new user communities
 - And to take more responsibility for operating BES beamlines
 - To be a model of BES sector operation, with >50% general user time
 - As of 2003-03 run, 80% time for competition (e.g. GU or PU proposals)
 - Thanks to XOR employees for continuing to provide dedicated user support (largest number of general users accommodated through XOR), and maintaining innovation



Welcome BES sectors

- BESSRC (11 and 12)



Staff joined APS under group leader Mark Beno as a new group in XOR as of 1/2003

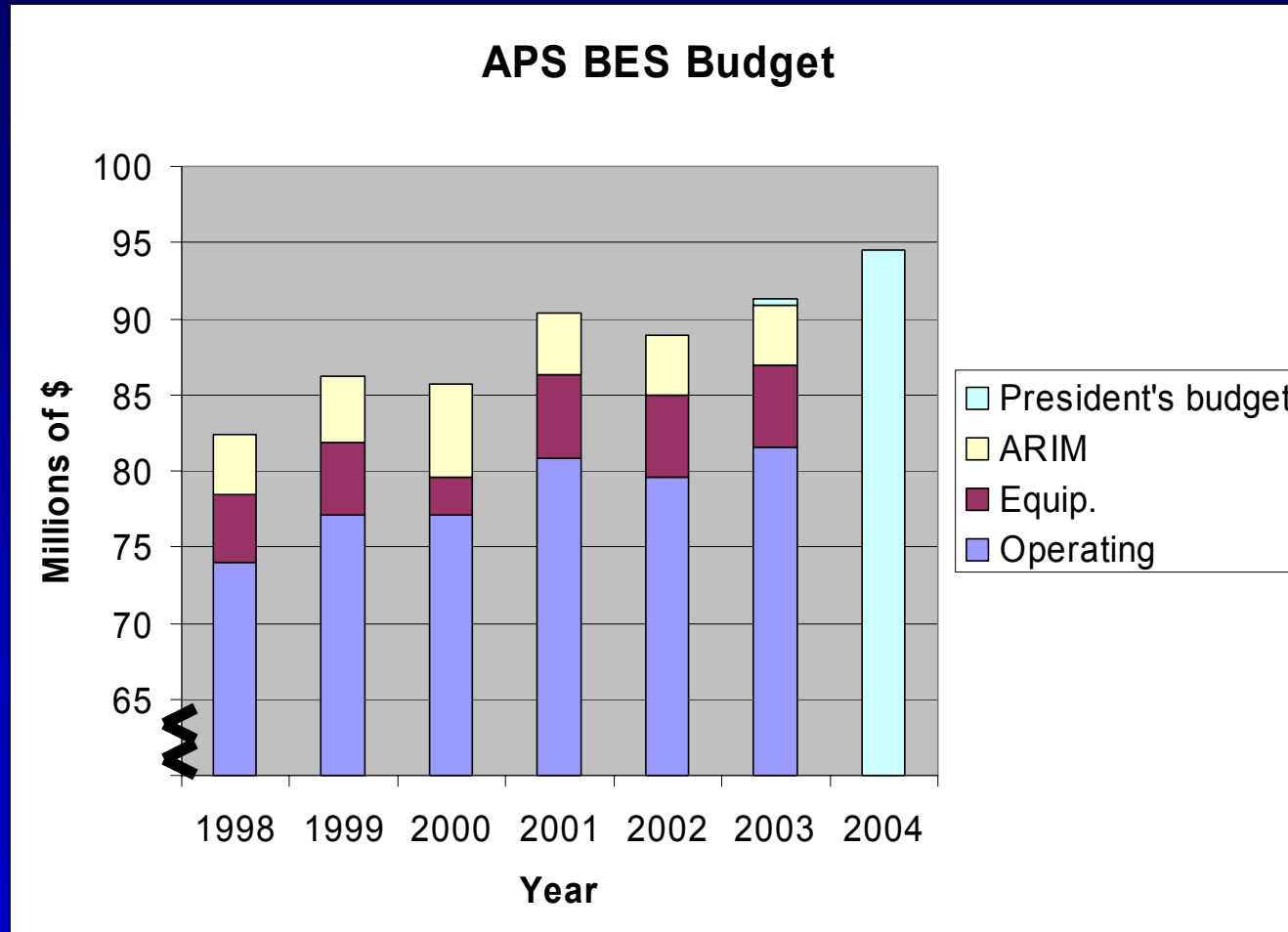
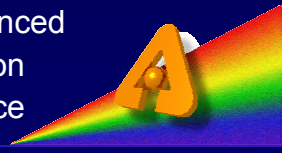
- Partners (some APS staff, other external support)
 - IMM (8)
 - MHATT (7)
 - PNC (20)

Sector	Added APS Staff	Jobs postings
8 (IMM)	2	0
7 (MHATT)	2	1
20 (PNC)	2	1
Total	6	2

Support for 8 staff members, M&S, capital = \$1770K in FY '03
Support of \$1M provided by ANL.

These three sectors offer 50% GU time and specialize activities

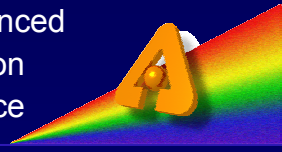
Future transitions anticipated gradually



Current FY '03 budget is \$90.89M

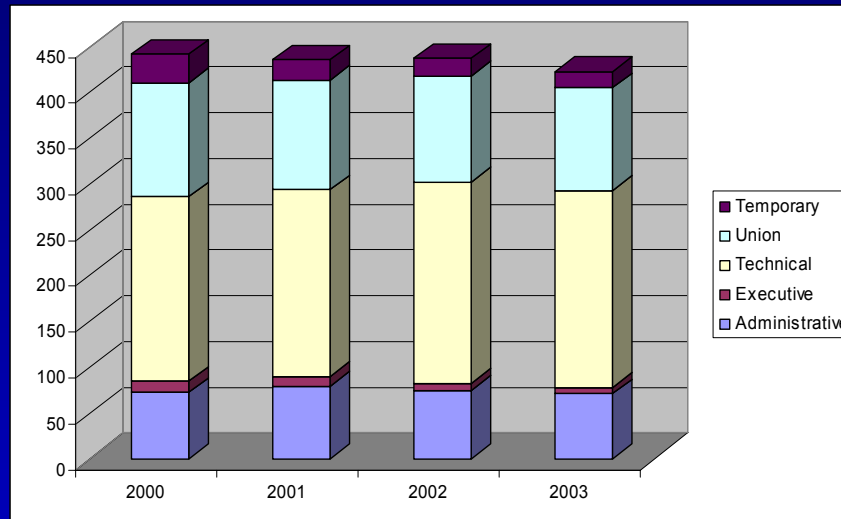
Includes \$1.3M transferred funding for BESSRC

FY '03 President's budget for APS was \$91.3M, \$1M ANL support for BES sector ops



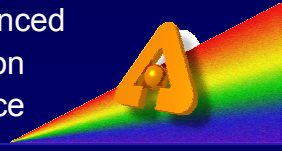
Staffing levels

- January 2002, 443.15 FTEs
- Today 420 FTEs (including 8 from BESSRC)

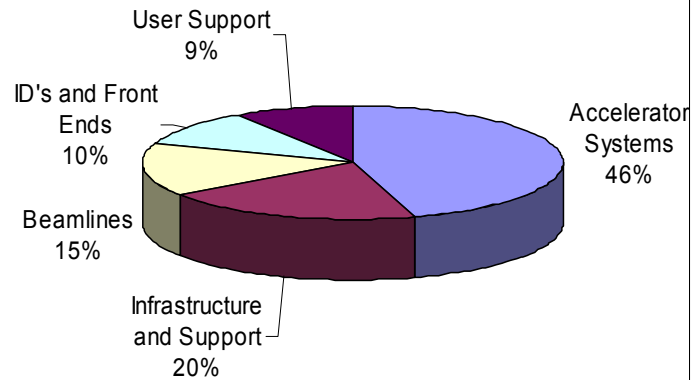


- Expect future growth in staff and budget for user support
 - other activities need to remain stable and well-supported

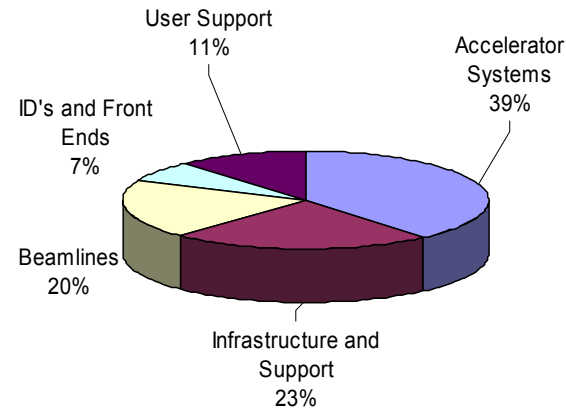
Increased emphasis on user support



APS Spending by Function FY02 Beginning

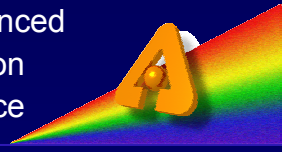


APS Spending by Function FY 03 Proposed

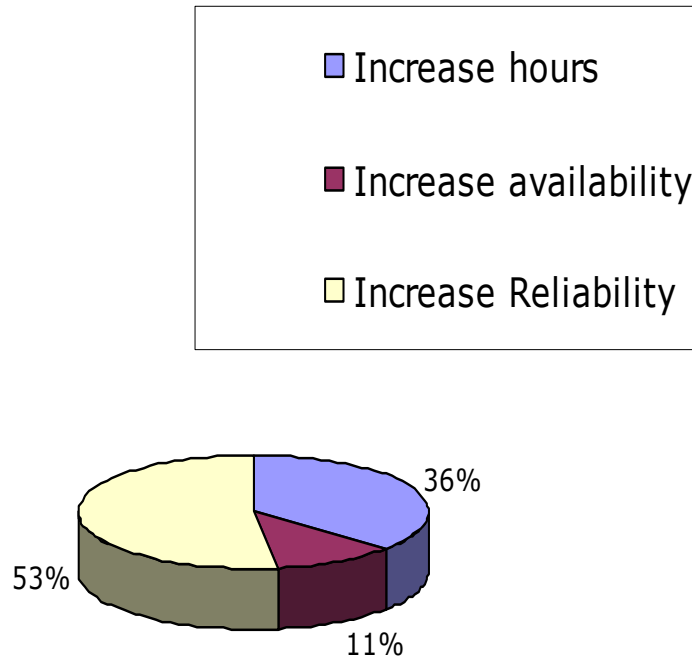


Moved ~7% of resources
towards user activities in 2002

Just in - User Survey 2003



Trade-Offs

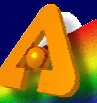


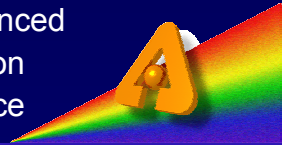
- 88% satisfied with APS performance
- 85% satisfied with service and schedule
- 79% satisfied with support from CAT staff
- 73% satisfied with support from APS staff

356 responses to e-mail survey

Promote dialog between facility and users ...

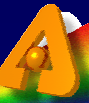
Advanced
Photon
Source





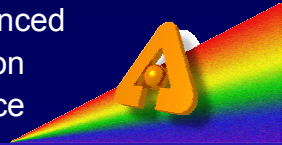
The Future

- BESAC subcommittee strongly recommended phase I and phase II upgrades (finish beamlines and optimize sources), and sector operations
- Working with BES to seek needed resources in coming years
 - Could be accommodated through increased operational budget at 15-30% level
- Exciting new science is emerging and will be facilitated by renewed investment
- Aim to leverage the best of both worlds at the APS— strong central operation of facility with strong partners



APS changes guided by mission:

- The mission of the Advanced Photon Source is to deliver world-class science and technology by operating an outstanding synchrotron radiation research facility accessible to a broad spectrum of researchers.
- Goals:
 - Operate a highly reliable 3rd-generation synchrotron x-ray radiation source
 - Foster a productive environment for conducting research
 - Enhance the capabilities available to users of the APS facility
 - Assure the safety of the facility users and staff and the environment
 - Maintain an organization that provides a rewarding environment that fosters professional growth
 - Optimize the scientific and technological contribution to the Department of Energy and society from research carried out at the APS



Conclusion

- APS is vibrant, healthy but still young
- We are here because of our Users, and together we will flourish
- Long-range plans to develop remaining beamlines, improve x-ray sources, enhance beamline operations are supported by BESAC subcommittee
 - Will lead to user community ~10,000 in a decade
- We want to define the state-of-the-art for 3rd generation synchrotrons
 - And be connected with 4th-generation sources